



REFUGE NARRATIVE REPORT

January 1, 1968 - December 31, 1968

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE
Simeonof NWR Semidi NWR
Bogoslof NWR

AND

IZEMBEK NATIONAL WILDLIFE RANGE

COLD BAY ALASKA

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COLD BAY ALASKA

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U. S. DEPARTMENT OF INTERIOR
Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service
Cold Bay, Alaska

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TABLE OF CONTENTS

Page Number

I. GENERAL

A. Weather Conditions. 1
B. Habitat Conditions. 1
1. Water 1
2. Food and Cover. 5

II. WILDLIFE

A. Migratory Birds 5
1. Aleutian Canada Geese 6
2. Lesser Canada Geese 7
3. Emperor Geese 7
4. White Fronted Geese 8
5. Black brant 8
6. Ducks 15
7. Swans 16

B. Upland Game Birds 16
C. Big Game Animals 17
D. Fur Animals, Predators, Rodents and other Mammals 20
E. Hawks, Owls, Crows, Ravens and Magpies. 24
F. Other Birds 24
G. Fish 25

III. REFUGE DEVELOPMENT AND MAINTENANCE

A. Physical development. 26
D. Control of vegetation 26
E. Planned Burning 26
F. Fires 26

IV. RESOURCE MANAGEMENT

A. Grazing 26
B. Haying 27
C. Fur Harvest 27
D. Timber Removal. 27
E. Commercial fishing. 27
F. Other Uses. 27

V. FIELD INVESTIGATIONS OR APPLIED RESEARCH. 27

VI. PUBLIC RELATIONS 33

A. Recreational Uses. 33
B. Refuge Visitors 33
C. Hunting 35
D. Violations 35
E. Safety 35

VIII. ITEMS OF INTEREST. 36

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE

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NARRATIVE REPORT

January 1, 1968 - December 31, 1968

I. GENERAL

A. Weather Conditions.

The weather record furnished below represents three points in the 1100 mile span of the Aleutian Islands Refuge. Cold Bay is at the eastern end, Adak slightly west of center, and Shemya at the western end.

A statistic that is not apparent in this presentation has to do with sunlight received. We have commented in earlier reports that Cold Bay is the site of the lowest recorded solar insolation in North America. The reader should not imagine that there are many stations recording such information. There are six in Alaska, five operated by the U. S. Weather Bureau, and the sixth by this refuge headquarters. The data are in terms of calories per square meter, which are not always meaningful. But the meaning of clear and cloudy weather is always meaningful.

The U. S. Weather Bureau defines cloudy weather as that existing when no more than .3 of the sky is clear. Partly cloudy exists when from .4 to (and including) .7 of the sky is clear, and clear weather requires .8 or more clear sky. The record at Cold Bay this year is 14 clear days, 60 partly cloudy days, and 292 cloudy.

The statistics for Adak weather are furnished by the Navy Weather Center, while those from Shemya and Cold Bay are furnished by the U.S. Weather Bureau.

B. Habitat conditions.

1. Water. Water management is not practiced on these refuges.

Climatological Data for Cold Bay obtained from

the U.S. Weather Bureau

1968

Month	Precipitation (inches)		Temp. (°F)			Wind(MPH)	
	Sleet/ Snow	Water Equiv.	Max	Min	Avg	Max	Avg
Jan.	6.8	2.77	42	7	28.3	59	18.6
Feb.	10.3	1.29	43	-1	24.0	53	17.0
Mar.	7.8	1.21	43	16	30.4	55	15.3
Apr.	5.1	1.37	50	18	34.2	39	16.1
May	2.1	1.30	62	25	42.7	47	13.7
Jun.	0	0.84	57	34	45.4	30	12.7
Jul.	0	0.99	72	42	52.9	33	15.6
Aug.	0	3.53	60	45	52.0	44	16.4
Sept.	T	2.55	60	32	46.8	36	14.0
Oct.	15.6	8.02	51	18	38.9	46	13.3
Nov.	6.7	3.32	45	20	36.0	45	16.4
Dec.	7.3	1.17	46	15	30.8	51	19.3
Totals	61.7	28.36	72	-1	38.5	59	15.7
1967	46.1	45.35	67	5	39.4	73	17.4
1966	63.7	30.28	63	0	36.5	62	16.9
1965	76.3	32.72	65	2	37.7	61	16.3
1964	52.5	26.51	69	6	37.4	59	15.9

Climatological Data for Adak obtained from

the U.S. Naval Weather Service

1968

Month	Precipitation(inches)			Temp (°F)			Wind (Knots)	
	Rain	Sleet/ Snow	Water Equiv	Max	Min	Avg	Max	Avg
Jan.	8.14	6.8	8.82	50	21	36	57	10
Feb.	2.48	12.6	3.74	43	22	32	66	13
Mar.	1.87	17.3	3.60	45	21	34	49	10
Apr.	3.51	14.9	5.00	47	22	36	48	11
May	0.93	2.4	1.14	54	31	42	45	11
Jun.	1.92	0	1.92	56	37	45	33	08
Jul.	2.31	0	2.31	65	42	48	30	09
Aug.	2.53	0	2.53	60	36	49	35	10
Sept.	3.10	0	3.10	58	35	48	44	10
Oct.	4.21	7.1	4.92	56	22	42.3	60	12
Nov.	4.05	26.0	6.65	46	19	36	40	11
Dec.	9.54	1.3	10.68	47	26	37	59	12
Totals	44.59	88.4	54.61	65	19	40	66	11
1967	54.77	108.8	56.6	68	06	40	74	10
1966	52.35	97.0	62.05	65	16	40	74	10.4
1965	57.27	98.8	67.15	68	6	38	85	9.5
1964	51.06	171.0	68.15	65	3	39	90	14.75

Climatological Data for Shemya obtained from

the U.S. Weather Bureau

1968

Month	Precipitation(inches)		Temp(°F)			Wind(MPH)	
	Sleet/ Snow	Water Equiv	Max	Min	Avg	Max	Avg
Jan.	5.3	1.77	40	22	33.4	62	23.0
Feb.	4.5	0.73	39	21	29.8	53	25.1
Mar.	3.9	0.98	41	21	32.2	56	21.2
Apr.	4.7	0.67	41	25	33.5	49	18.0
May	0.8	1.36	46	32	38.2	52	18.1
Jun.	0	0.80	49	36	42.1	37	13.5
Jul.	0	0.72	60	40	46.2	35	15.8
Aug.	0	1.88	56	41	48.2	30	13.6
Sept.	T	2.26	58	35	46.8	44	16.6
Oct.	2.2	2.78	51	26	40.3	53	21.9
Nov.	6.6	0.99	41	23	33.6	83	23.5
Dec.	6.9	2.33	42	21	33.3	85	23.5
Totals	34.9	17.27	60	21	38.1	85	19.8
1967	49.8	36.90	59	17	37.9	90	19.4
1966	42.0	25.43	56	17	38.1	69	20.0
1965	58.5	35.07	55	20	38.7	68	18.0

Throughout the refuge, precipitation for 1968 was low, unusually so at Shemya. During July and August while we were operating in that area the Pacific high was stronger than usual, sending the low centers farther to the north. Not only was there less, rain, but there was also less wind.

On the Izembek Range lake levels were low until the end of September when the fall rains came, belatedly. In late October fifteen inches of snow fell. Fortunately, the snow was wet so that it did not drift. Normally this much snow in our windy climate is paralyzing, but this snow lay and melted where it fell.

2. Food and Cover. This was a good year for berries on the heath of the Izembek Range. It was also a good year for the salmon berries *(Rubus spectabilis)*. There are many users of the berries on the heath ranging from ptarmigan through geese and foxes, and on to the brown bear, but the latter is (other than man) the primary user of the salmon berries.

II. WILDLIFE

A. Migratory Birds.

We have two interesting band recoveries this year. One (565-56198) came on the leg of a blue-winged teal taken at Adak Island. There are at most eight observations of blue-winged teal in Alaska, and only one reported from the Aleutians by Lucien Turner nearly eighty years ago. At the time of writing no return has been received from the banding office.

The second is of interest from quite a different viewpoint. It was on the leg of a Steller's eider, and we had put it there in September 1962. This is one of the early aluminum bands that on the leg of a blck brant would have had little probability of surviving six years. Yet the fact is that we are receiving reports of band recoveries from Steller's eiders wearing these bands for several years. As most of them are taken in the U.S.S.R. we had not seen the bands. The numbers on this band are as crisp and readable as the day we applied it to the bird's leg.

Many bird banders lacking experience with birds inhabiting sea water may not regard this as unusual. But this particular band was one of the last of its type used here because we feel that the impermanence of aluminum bands effectively nullifies the effort to band birds inhabiting sea water. In casting about for reasons why they survive on Steller's eiders and not on brant for example, one wonders about temperature differences. The brant migrate to Mexican waters where humans swim with some comfort, but the eiders winter here where the sea water if often below 32°F.

Aleutian Canada Geese. On May 19 Lt. Rudd Thabes, conservation officer on the U.S. Naval Station, Adak observed 29 Aleutian Canada geese feeding near Clam Lagoon. Both the description and photos leave no doubt as to the identification. Earlier that month geese reported as "honkers" had been sighted in Clam Lagoon.



Fig. 1 Aleutian Canada Geese on Adak Island
Photo by Rudd Thabes

An Aleutian Canada goose taken on the Delevan Refuge in the Sacramento Valley was reported. This bird taken in early January was described as "Slightly larger and more full bodied than the ordinary cackling goose. White band around base of neck about 1-1/2" wide in front and barely coming together in back."

An unusual record of an Aleutian Canada goose has come from Corvallis, Oregon. This bird joined a private flock at the residence of Mr. John Adair near Corvallis. The bird stayed for the summer and moulted, at which time it was captured and marked

with a regular Bureau band, and two red plastic poultry bands one on each leg. Its weight at the time was 1600 grams.

The Wildfowl Trust at Slimbridge, England reports receipt of a pair of Aleutian Canada geese, on loan from the Bureau. Thus are the "eggs" once swayed in one "basket" aboard the Coast Guard Cutter KLAMATH in 1963 at remote Buldir Island being dispersed.

Lesser Canada geese. Like last year the concentration of Canada geese did not reach its peak until mid-October. The first southbound migration occurred November 1st when wind conditions on the Izembek Range were favorable. Unlike the brant some Canada geese start this migration when wind flow is not suitable to carry them all the way across the Gulf of Alaska. Such was the case on November 1st. On that occasion the geese were heading into severe storm conditions, which they probably encountered in about 300 miles. At this point they would have been approaching Kodiak Island which was experiencing strong, turbulent winds that were head winds for the geese. We asked the Kodiak Refuge to check for increased numbers of Canada geese, but the weather was so rough, flying an airplane was out of the question. Unfortunately we were never able to trace this group of birds, which is a pity for to do so would have furnished added clues to migration conditions and routes.

But this is the annual fall dilemma. The migration of both Canada geese and brant is dependent upon atmospheric pressure patterns (in late October or early November) that produce strong westerly winds. In the case of brant these winds must blow all the way across the Gulf of Alaska. And in almost every case these patterns have developed in association with a strong storm center (low pressure center). As a result our knowledge about the migration has developed in adverse conditions and there are many things we have not yet learned. The birds' idea seems to be, "Let's wait until there's a strong wind blowing our way, and then we'll ride it."

The bulk of the Canada goose population from the Izembek Range started south on the 8th and 9th of November. On both days there was a stream of flocks passing south-eastward in full view of the town. So conspicuous was this event that even the kids watched it through their school-room window. We had warned the Federal Aviation Agency of the impending migration and from the morning of the 8th all aircraft flying the North Pacific were warned.

Emperor Geese. Lt. Rudd Thabes, Conservation Officer on the U.S. Naval Station, Adak reported observing emperor geese while he was conducting a flight from Adak in the central Aleutians to Dutch

Harbor in the eastern Aleutians. He reported observing these geese along the entire flight. The date was January 17, 1968.

While gathering brant data the following emperor goose data were accumulated.

	1968	1967	1966
Total adults	1195	1475	699
Total Juveniles	584	585	265
Total count	1779	2060	964
% Juveniles	33	28	27
Total broods	40	66	132
Mean brood size	2.8	3.3	2.5
Total young in broods	113	215	331

An aerial count conducted December 19, 1968 revealed 18,000 emperor geese on the Izembek Range,

White-fronted geese. Usually a few white-fronted geese appear on the Izembek Range, often in company with emperor geese, but this year none were observed.

Black brant. An important observation concerning brant was recorded May 8th. On this date three flocks of brant were observed at Thin Point, the southwestern limit of Cold Bay. These birds proceeded north, along the western shoreline of the Bay. The significance of this is that these birds were coming in from the open sea, not skirting the coast.

A note from Dr. T. W. Barry of the Canadian Wildlife Service indicates that the brant nesting in the Anderson River Delta of the Northwest Territories produced quite well, but those farther north on the Arctic Islands had a poor season.

In Izembek Lagoon the first south bound migrants were noted August 18th. The initial influx was rapid so that by September 3rd there were an estimated 100,000 in the Lagoon. Thereafter the numbers mounted more slowly. The last flock that we were able to identify as newly arrived, did so on November 3rd, just five days before migration.

Our readers may very well raise an eyebrow at the assertion that we can recognize a flock just arrived from the north amidst

such a concentration, but this is the fact. Gradual changes of social structure occur within the flocks in Izembek Lagoon. The families disintegrate, and with the elimination of aggressive behaviour that is characteristic of family groups, the flocks grow larger and fewer. Density of the flocks increases, and the size of the flocks limits the localities where they can be found. When a small, loosely grouped flock appears in an unexpected place late in the season it bears closer examination. Recently arrived flocks exhibit tiredness in two ways: they are less prone to fly than rested birds, and much less noisy. Finally we have never identified a late arriving flock of non-breeders. Our evidence urges the view that non-breeders are among the first brant to arrive, and perhaps that they all do, but we are by no means certain as yet.

Apropos the matter of late arrivals, Dr. T. W. Barry remarked that some brant lingered along the coast (Northwest Territories in Canada) as late as October 1st this year.



Fig. 2 An eelgrass bed in Izembek Lagoon, brant overhead. Photo by Will Troyer

Age group counts for 1968 totalled 21,278 birds, comprising 17,537 in adult plumage and 3,741 in immature plumage, or 17.58% juveniles. For comparative purposes these figures are offered for six years.

	Adults	Juveniles	Total	% Juveniles
1963	3,969	1,243	5,212	23
1964	10,727	4,432	15,159	29.21
1965	26,790	7,242	34,032	21.3
1966	12,647	8,547	21,194	40.3
1967	15,964	3,398	19,362	17.5
1968	17,537	3,741	21,278	17.6

Table I. Age Groups Counts of Black Brant on the Izembek Range for Six successive Years

For the reader unfamiliar with our circumstances and methods a brief description follows. Except for stragglers, the entire population of black brant assembles on the Izembek NW Range each fall, where adequate food resources permit accumulation of fat and protein reserves necessary for the migration to Baja Mexico. With the entire population present, a large sample that yields a numerical indication of first year and adult birds furnishes an accurate guide to reproductive success within the total population. To accumulate such a sample we observe the flocks resting and feeding on the water. This is done with the aid of a 20X spotting scope. First year brant have plumage characteristics that distinguish them from those in adult plumage, and we observe the flocks with this in mind. Each bird is observed to determine which plumage it is wearing and the results are recorded on two Veeder counters. Such family groups as can be identified are recorded in terms of their size.

From these data we determine reproductive success, which is expressed (as shown in Table I.) as percent juveniles in the population. Using the mean family size, i.e., number of juveniles per family, the number of families represented in the counts is available, and from this the number of reproducing adults. Family counts for 1968 are presented in Table III. When translated into frequency of occurrence per 1000 families (Table IV) it becomes apparent that variations in reproductive success are not reflected in major shifts of family size. Success or failure is reflected in the number of broods produced rather than in their size.

TABLE II Chronological Listing 1966 Brant Counts

Date	Area	Ad.	Juv.	Total	% Juv.
8/23	Grant Point	153	43	196	21.9
8/30	Grant Point	68	30	98	30.6
9/4	North End Neuman I.	2	1	3	
9/6	Grant Pt.	928	237	1165	20.3
9/17	South Side Applegate Cove	618	102	720	14.1
9/26	Round Isl.	767	317	1084	29.2
10/2	Outer Marker	241	61	302	20.2
10/2	South side Applegate Cove	1354	235	1589	14.79
10/7	South side Applegate Cove	1099	177	1276	13.87
10/11	Half Bay Pt.	11	6	17	
10/14	South End Applegate Cove	996	193	1189	16.23
10/15	South End Applegate Cove	1212	377	1589	23.72
10/15	Round Island	309	87	396	21.96

Corrected figure for 80 copy.

TABLE II (cont.) Chronological Listing 1968 Brant Counts

Date	Area	Ad.	Juv.	Total	% Juv.
10/16	Half Way Pt.	247	92	339	27.13
10/16	Outer Marker	1496	110	1606	6.8
10/17	South Side Applegate Cove	786	232	1018	22.78
10/18	"	1012	140	1152	12.15
10/23	Grant Point	1067	181	1248	14.50
10/25	Grant Point	46	21	67	
10/27	Grant Pt.	54	22	76	
10/28	Grant Pt.	43	44	87	
10/29	Half Way Pt.	688	110	798	13.78
10/30	Half Way Pt.	587	83	670	12.38
10/31	Outer Marker	886	133	1-19	13.05
10/31	Half Way Pt.	768	102	870	11.72
11/1	Outer Marker	1138	252	1390	18.12
11/1	Half Way Pt.	893	307	1200	25.58
11/3	Grant Pt.	68	46	114	
		17,537	3,741	21,278	17.58

TABLE III. FAMILY GROUP COUNTS FOR THREE YEARS

No. of juveniles in the family	Number of families observed 1966	1967	1968
1	31	53	19
2	44	133	54
3	66	115	46
4	34	42	20
5	16	9	5
6	4	3	
7		2	1
8		1	
9		1	
Total	195	359	145
Mean Family Size	2.85	2.57	2.55



Fig. 3 Black Brant Flying over the Izembek National Wildlife Range Photo by Chuck Tunns

The number of juveniles in the counts (3741) divided by the mean family size provides the number of families represented and therefore the number of reproducing adults. This permits a breakdown of the adult plumaged birds into two categories.

Reproducing adults	2,934 - 13.70%
Non-reproducing adults	14,603 - 68.63%
Juveniles	3,741 - 17.58%

Obviously 1968 was not a good year for reproduction in black brant.

The influence of weather on the behaviour of waterfowl is particularly spectacular in the case of black brant. Once biologically ready to set out on the southward migration, the behaviour of the entire population is regulated in this respect by atmospheric pressure patterns. Though the nature of the pattern is not always the same, one characteristic definitely is. This one is that westerly winds develop and blow all the way across the Gulf of Alaska. If this requirement is not met the birds simply wait until it is, and this may take as much as three weeks. Typically, the necessary wind flow develops in the southern quadrant of a low pressure center, and a study of the storm's track allows us to predict with accuracy the date of migration.

This year the wait was of two weeks duration and in that time we studied the weather charts closely. Inevitably the prolonged weather watch commanded the interest of the Weather Bureau personnel. Some found it difficult to believe that the birds could sense the conditions described, but as time passed it became increasingly evident that they were in fact waiting. On the morning of November 8th the surface weather analysis showed that a deep semi-stationary low located south of us had begun to move rapidly northward. The time had come. We issued a warning to the Federal Aviation Agency that a massive migration of geese would occur within a few hours, and went into the field to watch events.

Etched sharply against the white sky, echelons of brant were "stacked" for hundreds of feet in every direction. The entire population was in the air, performing a ritual that occurs each year in anticipation of migration. Big flocks lifted from the lagoon, assembled in numerous echelons and climbed to high levels where they flew back and forth for a time. Presently the formations dissolved and the amorphous flocks descended to the lagoon, where

they alighted momentarily and took to the air again. This time the flight was at low levels for awhile, until once more they went aloft. All day the massive flight continued, and at nine that night the exodus began. Three hours later the entire population, save for the few thousand that winter here, was gone.

Ducks. Although not the first canvasbacks to appear in our area, the presence of ten at Adak for several weeks in late February and March is noteworthy.

A flock of about 50 European widgeon appeared on the Izembek Range November 1st.

Shovelers are not always observed on the Izembek Range in fall but this year several sightings were reported.

Usually greater scaup appear on the Izembek Range in conspicuous numbers during the fall. They are rather specific in their choice of lakes, hence the flocks tend to comprise several thousand birds. This year these flocks were conspicuous by their absence.

Also conspicuous for their absence until quite late were the pintails. Usually these are present in large numbers most of the fall, but this year they were here only briefly.



Fig. 4. Banding Steller's eiders. Palmer Sekora, Margaret Schmidt, Bob Jones with struggling drake eider. Photo by Will Troyer

Three drives of moulting Steller's eiders the 13th, 14th, and 15th of September netted 144 birds. None of these had previously been banded. At that time the drakes were well advanced in the moult. September 24th the majority of the hens were still unable to fly.



Fig. 5. A catch of Steller's eiders, mostly drakes. The striking coloration of the breeding plumage is almost wholly absent in the moult. Photo by Will Troyer

Swans. Whooper swans were reported from Atka in January and Adak in March. These birds have proven exceedingly wary, and efforts to collect specimens for the National Museum have proven futile for three successive years.

Sixty whistling swans were observed on Unimak Island in mid-August. Two broods, each with four j veniles were included.

An important observation of whistling swans was recorded December 26th. On this date 146 swans were concentrated on Swanson's Lagoon, Unimak Island. This tends to confirm our view that the swan population in this area is non-migratory.

B. Upland Game Birds.

There is little to report other than a comment concerning Agattu. On Agattu the introduced Arctic fox has been severely

depleted (by our activities) since 1964. To date no sign of remnant rock ptarmigan, once native to the island, has been observed though it has been sought for two successive years. We still hope that survivors persisted in the mountains, as they did on Amchitka.

C. Big Game Animals.

Brown bear. Since 1949 the harvest of brown bear (*Ursus arctos*) on Unimak Island of the Aleutian Islands National Wildlife Refuge has been regulated by a permit system. Each year twenty-five permits have been available to hunters on a first come-first served basis. It has been only in the past 4-5 years that the full 25 permits have been issued. The number of applicants increases each year (Table IV). Both legal and illegal hunting pressure has increased significantly on Unimak Island. This increase is not expected to stop. To determine whether the present Unimak Island brown bear population is being correctly managed a basic inventory was conducted in August and September of 1968. Data were also collected for the Izembek bear population.

TABLE IV. Number of Applicants for Unimak Bear Permits

Season	Number
1968-69	38
1967-68	32
1966-67	31
1965-66	34
1964-65	27
1963-64	No Data

OBJECTIVE

To determine distribution, total numbers, population structure, and population dynamics of the Unimak Island brown bear population.

PROCEDURE

The vastness of Unimak necessitates aerial inventory during that time of year when the brown bear population is concentrated on the salmon streams. This generally occurs during the early part of August. Survey flown this year extended from August 9, 1968 to September 9, 1968. Basic survey was flown through August 18 with duplicate surveys through September 9. Surveys was conducted using a Piper Super Cub (PA-18-150) on balloon tires. Flights were upstream or downstream on each stream at altitudes varying from 300 to 500 feet, depending on terrain, visibility and winds. All

streams capable of sustaining salmon runs were surveyed. Time of observations ranged from 0700 AST to 1100 AST for morning counts, and 1500 AST to 1900 AST for the evening replicate counts. Time, distance, and the press of other duties eliminated replication of both morning and evening counts. The evening counts are therefore considered replicate of the morning counts.

All data were recorded on data sheets. Data recorded were: females with young of the year, females with yearlings, lone bears. All groups are broken down into size classes. Date, Time, and location of each observation was noted. Size and location of all salmon runs were noted.

RESULTS

Since this is the first basic brown bear inventory on Unimak Island and Izembek NWR as a whole no survival data or population trends can be established. Only the population structure and productivity can be ascertained to any degree. Comparisons are made to that data collected by the Alaska Department of Fish and Game for the Alaska Peninsula brown bear population.

A total of 56 bears were classified on Unimak. Based on this figure, the area surveyed, area not surveyed, and animal distribution a minimum figure of 65 bears is thought to exist. Over-all productivity of the Unimak population is less than that of the Peninsula. This is especially true of the yearlings with the yearling litter size far below that of the Peninsula. The low productivity plus a relatively low population makes this population susceptible to overharvest.

Known legal harvest does not appear to be significantly large. It is thought that illegal kill might be the limiting factor. Reports of illegal kills are scattered, many times unreliable, but the total illegal kill probably equals or surpasses the total legal kill. Unimak is visited and is more accessible to commercial fishermen, military, and oil interests than it is to the sportsman. Many of these people are not cognizant of the Refuge permit system, and many probably do not concern themselves about permits knowing the chance of being caught in violation is quite low. We have no figures on illegal kill but for management purposes estimate it to be equal or greater than legal kill.

Comparing the data to that of the Peninsula the most significant difference is in "Other Bears". This indicates a larger population of harvestable bears proportionately than on the Peninsula.

But the population of Unimak appears to be quite small so that "Other Bears" is not a large figure (20). Even if fifty percent of the mammals were enumerated this figure does not justify issuance of twenty-five permits. We are recommending that permits available be limited to fifteen.

Eighty-eight bear were noted on the Izembek NWR. Productivity is lower than the rest of the Peninsula but not significantly so.

TABEL V. Summary of Composition Counts

	Sow w/1 cub	Sow w/2 cub	Sow w/3 cub	Sow w/4 cub	Sow w/1 Yrl	Sow w/2 Yrl	Sow w/3 Yrl	Other Bear	Total Bear
Unimak	2	4	1	1	4	1	0	20	56
Izembek	4	6	3	0	2	5	3	19	88

TABLE VI. Breakdown

	Izembek	Unimak	Alaska Pen. 67	Alaska Pen. 66
Per cent Sow/young	26	24	27	22
Per cent Cubs	28	29	38	33
Per cent Yearlings	24	11	15	16
Per cent Cubs & Yearlings	52	40	52	49
Per cent Other Bear	22	36	23	29
Total	100	100	100	100

TABLE VII. litter Sizes

	Izembek	Unimak	Alaska Pen. 1967	Alaska Pen. 1966	Alaska Pen. 1965
Cub	1.9	2.1	2.1	2.2	2.1
Yearling	2.1	1.2	2.0	2.2	2.0

TABLE VIII. Known Legal Harvest - Unimak Island

	Spring	Fall	Total
1968	2	5	7
1967	4	4	8
1966	6	1	7
1965	6	4	10
1964	10	5	15
1963	-	-	3 known
1962	3	-	3
1961	1	-	1

No reliable data are available before this period.

Two brown bears, both two years old, were evidently killed in August near town by older bears. The carcasses were examined and showed no evidence of bullet holes, but of rough handling by other bears.

On Adak the desired harvest of fifty caribou seems likely to be met. By early December a total of 40 had been taken, plus three collected for scientific purposes, and two dead of entanglement in wires.

These animals, introduced to the island in 1958 and 1959, are producing specimens that weigh up to 700 pounds, making them the world's largest caribou. The population is quite small, 200-250, and management plans are to keep it that way. With the reproductive potential caribou possess this may be difficult. Because of their size hunters tend to select trophy class animals and the harvest is heavily loaded to bulls. Of the forty taken this year only eight were cows.

About 1000 caribou moved onto the Izembek NWR in November. This respresents a substantial influx of animals from the north.

D. Fur Animals, Predators, Rodents and Other Mammals.

This year the long delayed project to secure live voles *(Microtus oeconomus amakensis)* from Amak Island reached fruition. In late May and early June we enjoyed a stretch of perfectly calm weather during which time we maintained two men on the island for a week. Palmer Sekora went over first to be replaced later

by Dr. Francis H. Fay of the Arctic Health Research Lab.

Amak Island is an extinct volcanic dome that stood upon the Bering Land Bridge during the last great glacial advance, and emerged as an island when the water rose. The voles that then inhabited the land bridge survived on Amak and the Alaska Peninsula. Thus for about 8000 years the two populations have been isolated, ample time for evolutionary changes to develop. The Amak race had already been described (in 1930) by O. J. Murie but further study required live animals, so we went to Amak.



Fig. 6. The Basaltic Dome of Amak
Photo by Palmer Sekora

Amak Island lies eleven miles off the barrier islands that form Izembek Lagoon. Because of this proximity an ice bridge forms to the mainland in the colder winters. By this means the red fox *(Vulpes fulva)* native to the Alaska Peninsula has gained access to the Island, and a dense population has developed. Despite this we found the vole population at a high level. The foxes were quite tame and individuals escorted the trappers about the Island, marking the traps with urine as soon as they were set. This obviously created difficulties, but more serious was the necessity to beat the foxes to the traps once a vole fell in one. One particularly insistent fox was reluctantly dispatched.



Fig. 7. A Fox Pup on Amak
Photo by Palmer Sekora

It is interesting to speculate on the ecology of these two dense populations. One would expect extreme fluctuations and certainly that the vole population would be low by spring. But this leaves out of consideration the influence of the sea. On every island in the Aleutians where fox introductions have been successful these animals have ultimately turned to the sea for their food. Most of these food resources come directly from the sea, but one is a product of the beach habitat. This is the kelp fly *(Fucellia)*. The adults appear in swarms so dense they are unpleasant to walk through. The larvae feed on the tons of kelp *(Alaria fistulosa, Nereocystis luetkeana,* and *Laminaria ssp)* washed ashore, and burrow into the sand or gravel to pupate. Also available on the beaches are myriads of amphipods. On Amak and adjacent rocks is a large population of Steller's sea lions *(Eumetopias jubata)*, numerous harbor seals *(Phoca vitulina)*, and a growing population of sea otters *(Enhydra lutris)*. Many of these marine mammals that die are washed ashore where the foxes and bald eagles feed on them. Whales and occasionally walrus carcasses wash ashore on Amak. In fact, the storm beach on the southern end of the island constitutes the most remarkable accumulation of bones noted in the Refuge. From its appearance this cobblestone beach is subjected to a furious onslaught during the winter months, which together with the tidal currents that converge on the Island would partially account for the large accumulation of bones.



Fig. 8. Steller's Sea Lions on Amak
Photo by Palmer Sekora

One other factor enters into the accumulation of bones. Until the beginning of the twentieth century this same cobblestone beach was frequented by large numbers of Pacific walrus. It was probably one of the major sources of ivory for Aleut use prior to 1741. Subsequently this resource was exploited until the walrus completely disappeared from the area. Apparently the tradition was not lost, for in recent years walrus have again used the island in winter.



Fig. 9. Our campsite above the Cobblestone Beach on the South Side of Amak. The Spherical Objects are Japanese Fishing Floats Cast Ashore.
Photo by Palmer Sekora

The northern side of Amak is precipitous and is the site of a large pelagic bird colony. Puffins, murres, kittiwakes and two species of cormorants are the principal species.

Evidence of an Aleut village was noted above the cobblestone beach. Veniaminov (Notes on the Islands of the Unalaska District) mentions a boat lost in 1809 while crossing from Amak to the coast of Aliaksa (this is the name by which the Alaska Peninsula was then known, and the origin of the name Alaska). The name Amak is Aleut in origin stemming from the word "amaq" which means "blood." We are unaware of any record indicating why that name was chosen.

Another legal step was taken in the right direction this year with elimination of the bounty on wolverines, and partial elimination of the one on wolves. In certain parts of Alaska the wolf bounty is regarded as a welfare measure and its elimination will be strongly opposed. Thus is one of our finest trophy animals incontinently cast away.

Speaking of trophies, a yearling female wolf was killed in the Cold Bay dump in September.

In the fall harvest of sea otters the Alaska Dept. of Fish and Game took 425 in the central Aleutians. 62% were females.

E. Hawks, Owls, Crows, Ravens and Magpies.

Five bald eagles were banded here this year, four young in nests at Adak, and one immature adult at Cold Bay. The latter was caught by a single toe in a trap set for wolverine.

One luckless raven dropped into a fifty gallon drum being used as a garbage container. Once inside it could not spread its wings and eventually we learned of it. It was a very subdued bird when we lifted it out, banded and released it.

In December a concentration of bald eagles numbering 75 to 100 birds was noted on the Izembek Range in an area where late running salmon were available.

F. Other Birds.

A glaucous-winged gull which we banded at Amchitka as a nestling July 4th 1961 was collected on Amchitka Feb. 25th 1968.

During the night of Sept. 27th two Leach's petrels and two bar-tailed godwits flew into the side of a hangar at Cold Bay. One of the godwits broke its neck, but the other three were just knocked out. Both species are a little unbelievable to persons not students of ornithology so we were summoned the first thing on the morning of the 28th. Nothing was wrong with the petrels, they just needed to be tossed into the air where they could spread their wings; so we banded them and did just that. The godwit, however, was still groggy and could not fly so we kept it around for a day. When it recovered it too was banded and released.

August 26th a color-marked ruddy turnstone was observed. This bird had been so marked on St. George Island in the Pribilof Island group this year. These marked birds range throughout the central Pacific and as far south as New Zealand and Australia.

Numerous golden plovers were observed in migration during the fall, some on Shemya at the western end of the Refuge and others on the Izembek Range at the opposite end. Several flocks were still present when 15 inches of wet snow fell October 23rd.

The introduction of willows on the headquarters site has encouraged more "dicky birds" to stop. Among these has been an occasional bright yellow spot in the form of a Wilson's warbler.

In May a pilot reported a continuous raft of birds along his flight path for 25 miles. These were sea birds and presumably shearwaters, for similar concentrations of these birds have been reported before. Dr. Victor Scheffer in Murie's Fauna of the Aleutians described 50 square miles of shearwaters in the same pass. We decided to play with figures a bit in an attempt to translate this into a numerical figure. We had to make an assumption as to distribution within the population for a starting point so we decided on one bird per square yard. Dr. Scheffer's account indicated a much higher density for they were not all on the water, but we had to start somewhere. A few pencil scratchings indicated there are a bit more than three million square yards in a square mile, and since no one was going to believe the figure to which this would lead we abandoned the project.

G. Fish.

The escapement of salmon in the streams emptying into Izembek

and Moffet Lagoons was good, thanks to an early closure of commercial fishing. This was an important producer of salmon, but heavy overutilization for several years has taken its toll. How many years will be required to restore the fishery is an important question. At least with good escapement in the streams there is the possibility of success. Since these fish are important members of the ecosystem we are seeking to maintain on the Range we are deeply concerned.

III. REFUGE DEVELOPMENT AND MAINTENANCE

A. Physical development.

The opening phases of master planning for the Izembek Range began this year at the conceptual level. Since the Range is a prime candidate for inclusion in the wilderness system almost in its entirety, decisions needed to be taken concerning what developments if any should be planned.

Establishment of grass cover on the headquarters site continued. This project has begun to yield rewards in reduced erosion and reduced volume of earth that must be removed from the buildings.

A much needed coat of paint was applied to the exterior of the headquarters buildings.

D. Control of vegetation. Not practised here.

E. Planned burning. Not practiced here.

F. Fires. One of approximately 40 acres started by unwise camper June 12th. In this case a boy was trying to build a fire in a cabin at Kinzarof Lagoon. The stove was a crude makeshift arrangement that didn't work too well. In his haste the boy threw some gasoline onto the fire and ducked out when the whole thing erupted into flame. We were afforded an opportunity to exercise our back-pack pumps. A number of men from the local Air Force site joined us in subduing the fire.

IV. RESOURCE MANAGEMENT

A. Grazing. Caton Island, near Cold Bay, is the only one of the

Aleutian Islands for which a grazing lease is available. The operation is a small one, with beef sold locally.

B. Haying. Not practised here.

C. Fur harvest. Fur harvest is regulated by state law.

D. Timber removal. Trees are not native to this region.

E. Commercial fishing. Substantial commercial fishing is done in both Izembek and Aleutian refuges, but this is regulated by state law.

F. Other uses. The use of Amchitka Island as a nuclear bomb testing site. An article from Audubon magazine discussing this matter is included in this report.

V. FIELD INVESTIGATION OR APPLIED RESEARCH

Studies of the ecology of Izembek Lagoon continued. These studies, now conducted by the Institute of Marine Sciences, University of Alaska are concerned with such things as nutrient uptake, carbon dioxide cycle, the effects of pollution, production in the eelgrass, vertebrate and invertebrate populations, etc. A rather efficient laboratory took form this year at Grant Point where the major work is done. Our contribution to this valuable investigation lies in making available certain items of necessary equipment.

In July we proceeded to Agattu and continued the effort to restore the Aleutian Canada goose. The refuge manager and a temporary employee, Larry Baker from Anchorage made this expedition. Its purpose was to locate surviving foxes and destroy them. This was the third year in the effort to eliminate the introduced Arctic fox.

We observed no foxes, but did observe tracks of single foxes in two places on the island. In each of these cases poison bait stations were provided.



Fig. 10. Our Campsite in Aga Cove, Agattu Island. Note the Two 100 Gallon Pillow Tanks. Photo by Robert D. Jones

This year we established camp on the eastern side of the island, in Aga Cove. This proved to be the better of the two campsites we have used on Agattu, and was within easy running distance of Shemya, the base from which we operated. Unusually fine weather prevailed during our time on Agattu, making the operation much shorter and simpler than usual.

We were equipped to make landings in rough conditions on the south side, where we had been frustrated in our efforts to get ashore. Our equipment included wet suits and an inflatable life raft. Though we used the latter in several landings it was never necessary to use the wet suits. We searched the south side from close inshore, looking for the tell-tale trails that reveal the presence of foxes, and landed in several places.

The single most pervasive impression we carried away from Agattu this year was of birds. Since effective elimination of the foxes the avian population has rapidly expanded. We noted in this report last year that many new nesting sites were available to the pelagic birds and they were beginning to employ them. This fact is even more true this year. Cormorants that had been forced to nest on the sheer cliffs were now choosing sites on low banks and headlands. Withe the expanded nesting areas available, the population is expanding.



Fig. 11. Pelagic Cormorants Roosting at Cape Sabak, Agattu Island. Photo by Robert D. Jones



Fig. 12. Steller's Sea Lion Bull and Glaucous-winged Gull near Cape Sabak, Agattu Island, Photo by Robert D. Jones

Suprisingly, even the "dicky bird" population has expanded. It is difficult to understand how foxes could influence song sparrows, wrens and snow buntings on an Aleutian Island. The possibility that the expansion of "dicky birds" is not related to the fox elimination must be considered. For the present it is enough to note that the beaches of Agattu literally swarm with them.

Our visits to the south side of Agattu in previous years had bordered on being harum-scarum. In fact whenever we rounded Cape Sabak we had snugged down and stood well away from the shore. This time the fine weather allowed us to run inshore and we saw some of the most pictorial scenery in the Aleutian Islands. We also learned that we had missed quite the largest murre and kittiwake colony on the island.



Fig. 13. The East Side of Agattu Island, Looking North From Cape Sabak.
Photo by Robert D. Jones

One point on the island we had never reached was the WWII radar site overlooking Karab Cove. The fine weather allowed us to anchor the dory in the open North Pacific Ocean, land in the life raft and climb to the site. The reader may be assured that we put down adequate anchor gear to hold the dory, the fine weather notwithstanding.

We had two objectives in reaching the radar site: (1) the thought that foxes might have dens under the buildings, and (2) we wanted to consider means to dump the still standing 100 foot high tower off the cliff. There were no foxes and no sign of them. Most of the buildings had been demolished by weather and we burned the major pile of rubbish remaining. But what to do with the tower? We had with us a 36 inch stillson wrench, the jaws of which at their maximum opening would just fit the nuts on the anchor bolts holding the tower down. We tested these nuts and concluded we would need a wrench about twelve feet long

to turn them. The legs are made of angle iron one inch thick, twenty inches on each side of the angle. The means at our disposal were clearly inadequate to dispose of the tower.



Fig. 14. A colony of Kittiwakes and Murres in Aga Cove, Agattu Island, Photo by Robert D. Jones



Fig. 15. Kittiwakes in Aga Cove, Agattu Island. Photo by Robert D. Jones

Two birds that we very much wished to see were conspicuously absent. One of these was the Aleutian Canada goose and the other the rock ptarmigan. We hope that Canada geese from Buldir will re-colonize Agattu but that may not occur until we put captive goslings on the island. The ptarmigan may have survived in the mountains, as they did on Amchitka, but we have not gone up there to learn. Although still not abundant we observed more mallards than on earlier visits to the island. The common eiders have noticeably increased and are now common on the main island itself. Heretofore they were restricted to offshore islets, but now they appear in numbers on all the beaches where they feed on amphipods. They now nest in suitable lakes on the main island, just as they did on Amchitka after the elimination of foxes and before the bomb people came.

Agattu presents strong vegetative contrasts. Its geologic history has resulted in a rolling tableland with high headlands. Streams have cut deep ravines leading toward the interior. The headlands and these ravines are mantled with a lush vegetative cover, but inland the aspect is much more impoverished. One of the more striking examples is furnished by the Kamchatka rhododendron.



Fig. 16. The Kamchatka Rhododendron on the Tableland of Agattu Island. Photo by Robert D. Jones

One of the major logistical problems involved in these expeditions centers around adequate fuel to operate the engines. We have successfully used fifteen gallon drums to handle fuel but they weigh ninety pounds and are awkward to muscle in and out of the dory, and up and down the beach. This year we introduced an innovation that promies to be a boon. We purchased two one hundred gallon pillow tanks, the necessary hardware including a pump, and one hundred twenty five feet of gasoline hose. Using these we simply pumped fuel into and out of the dory. The time involved, as well as effort was much reduced.

After returning to Shemya from Agattu we captured five fixes from nearby Nizki. Because of light colored summer pelage these animals had been viewed as possibly the product of mutation. They proved, however, to be the normal white phase.

VI. PUBLIC RELATIONS

A. Recreational uses. June 15th a group of 75 members of the American Ornithologists Union visited us. The annual AOU meeting was being held in Fairbanks, Alaska and these persons had arrived early to visit Cold Bay, Umnak Island and the Pribilof Islands.

B. Refuge visitors:

Date	Name	Organization	Purpose of visit
Jan 5	Turk Mayfield	FAA, Anchorage	Investigator
Jan 26	William Smoker	BCF,Auke Bay, Als.	King Crab Invest.
Feb 26	C. Peter McRoy	U. of Alaska	Eelgrass studies
Feb. 28	John J. Burns	ADF&G,Nome Alaska	Courtesy
Feb 28	Ed Muktoyuk	ADF&G, Nome Alaska	Courtesy
Feb 28	John Baust	U. of Alaska	Courtesy
Feb 28	Capt. T. Hansen	Master,ALPHA HELIX	Courtesy
Feb 28	Capt. Merkley	Pilot,ALPHA HELIX	Courtesy
Mar 9	Sgt. Anderson	Air Force, Cold Bay	Courtesy
Mar 9	Sgt. Tulin	Air Force, Cold Bay	Courtesy
Mar 26	George Tillbury	Power Plant Opr.	Business
Apr 10	Max Thompson	Southwestern College Winfield, Kansas	Courtesy
Apr 22	Jim Branson	BCF, Kodiak,Alaska	Courtesy
Apr 23	Floyd K.Drebill	Pan American Petr.	Discuss oil oper.
Apr 23	Dell Redding	Phillips Petr.Corp.	Discuss oil oper.
Apr 23	Mel Monson	BCF, Juneau,Alaska	Oil Business

Apr 23	Jim King	BSF&W,Juneau	Oil Business
Apr 23	W.C. Bishop	Western Oil & Gas	Discuss oil oper.
Apr 23	LeRoy Sowl	BSF&W,Anchorage	Courtesy
May 2	Will Troyer	BSF&W,Anchorage	Wilderness studies
May 2	Mr. Jacoby	Regional office	Refuge Planning
May 2	Mr.Van den Akker	Regional office	Refuge Planning
May 7	Dr. Carlton Ray	John Hopkins Univ.	Join ALPHA HELIX
May 7	Dr. John Krog	Oslo, Norway	Join ALPHA HELIX
May 9	Charles D.Evans	BSF&W, Anchorage	Check Pen.Oil Activ.
May 9	O. James Seidl	BLM, Anchorage	Check Pen.Oil Activ.
May 9	John Merrick	BLM, Anchorage	Check Pen.Oil Activ.
May 13	Dr. David R.Klein	Univ. of Alaska	Courtesy
May 13	Dr. Dale Guthrie	Univ. of Alaska	Courtesy
May 14	Dr. David Hoopes	BCF, Juneau	Courtesy
May 21	Mike Uttecht	Cold Bay	Discuss Moffet Bay oil operation
May 29	C. Peter McRoy	Univ. of Alaska	Eelgrass studies
Jun 3	Dr. Francis Fay	Artic Health Research	Captrue voles-Amak Isl.
Jun 5	Dr. John Goehring	Univ. of Alaska	Join ALPHA HELIX
June 5	Dr. Donald Hood	Univ. of Alaska	Join ALPHA HELIX
Jun 6	Joan Groves	Univ. of Alaska	Join ALPHA HELIX
Jun 6	Stephen Tack	Univ. of Alaska	Fish Research
Jun 6	David Brickell	Univ. of Alaska	Izembek Study
Jun 14	Dr. D. Aharma	Univ. of Alaska	Izembek Study
Jun 14	Dr.Patrick Kinney	Univ. of Alaska	Izembek Study
Jun 14	Nancy McRay	Univ. of Alaska	Eelgrass Studies
Jun 17	Will Troyer	BSF&W,Anchorage	Wilderness Studies
Jun 20	Joe Riendle	Alaska Geophysical	Moffet Bay Oil Oper.
Jun 26	Dr. David Stone	Geophysical Inst. Univ. of Alaska	Courtesy
Jun 26	B.N.Chatterjie	Univ of Alaska	Courtesy
Jun 26	Doublas K. Bingham	Univ. of Alaska	Courtesy
Jul 10	Ford Wilke	BSF,Seattle	Courtesy
Jul 11	Major James Kunkel	Air Foce,Cold Bay	Courtesy
Jul 11	Sgt. Andrews	Air Force,Cold Bay	Courtesy
Jul 15	Dr. R. Biebl	Austria	Izembek Study

Jul 16	Mr. Joe Puncochar	BSF&W,Wash. D.C.	Courtesy
Jul 16	John C. Walsh	ISPA, Boston,Mass	Courtesy
Aug 2	Dick Nensel	BSF&W,Kodiak,Als.	Bear Survey
Aug 12	Dr. David Hoopes	BCF,Auke Bay, Als.	Shellfish Inves.
Aug 15	Walter K. Muench	Grumman Aircraft, Bethpage, New York	Courtesy
Aug 15	Dr. Preston Cloud	Univ. of Calif.	Courtesy
Aug 15	Charles E. Behlke	Univ. of Alaska	Courtesy
Aug 15	Dr. Donald Hood	Univ. of Alaska	Courtesy
Aug 22	John McKeever	Pan Amerc.Petrol	Discuss oil oper.
Aug 22	Bob Logan	Marine Surveyor	Discuss oil oper.
Sep 18	Ancel Johnson	BCF, Seattle	Mammal studies
Sep 23	Jim Shaw	Realty Br.Portland	Quartes appraisal
Sep 25	Bernard Keating	Nat'l Geo. Wash.D.C.	Business
Oct 1	Robert Logan	Marine Ins.Appraiser	Discuss Nelson Lagoon oil barge
Oct 1	Mr. Rector	Pan Amer.Oil Corp.	Discuss oil activ.
Oct 1	Mike Uttecht	ADF&G Commission	Discuss oil activ.
Oct 28	Carrol Meyer	Geophysical Serv.	Discuss oil activ.
Oct 28	McVeigh Pattillo	Offshore Navigation	Discuss oil activ.
Oct 28	Dr.W.S.Laughlin	Univ. of Wisconsin	Archeological Discuss.

C. Hunting. Shooting areas are not maintained. All of the Izembek Range is open to hunting, trapping and fishing, although next year the area adjacent to the road network on the Range will be closed to brown bear hunting by state regulation. The function of this closure is to provide a small reservation in good brown bear habitat for the public that wishes to see live bears.

D. Violations. No violations in the normal sense were handled by refuge personnel.

However, a trespass by oil exploration personnel was scotched by refuge efforts. In this case a geophysical unit was in the process of establishing camps on the refuge. These were to be used for radio direction and range finding equipment in conjunction with offshore seismic investigations. No permits had been issued for this activity so we directed them to take their equipment and personnel off the refuge.

E. Safety.

(1) Our dozen safety meetings this year were largely concerned with aspects of boat operations. One constant requirement for boating safety in our operation is effecting a landing. Personnel not

acquainted with behaviour of a boat in surf or surge must be instructed in keeping out of the boat's way. Since the boats we use weigh a thousand pounds and are commonly carrying over a thousand pounds the need to keep clear is evident.

Another requirement is lifting. Our main engine weighs 150 pounds, and since it must be lifted in and out of the boat at each landing and launching the method of doing so becomes important. This, of course, is critical if the landing is rough.

(2) We had no accidents
(3) Record to date: 2464
(4) The station safety plan was completed and approved this year.
(5) Our entire supply of life jackets was replaced.

VIII. ITEMS OF INTEREST

This year oil prospecting became a serious reality on the Alaska Peninsula. The first problem arose when a geophysical company requested a permit to conduct seismic explorations in Moffet Cove within the Izembek NWR. Since this is tide water the jurisdiction rests with the state. We busied ourselves with mustering opposition and the permit was denied, but one was issued to work outside the Range. We kept daily watch over their activities.



Fig. 17 Part of the Equipment Employed in Seismic Operations Outside the Wildlife Range
Photo by Palmer Sekora

The next problem came with the discovery that Pan American Petroleum, drilling an exploratory well about 40 miles northeast of the Range, was making ready a barge for storage of 600,000 gallons of fuel through the winter. Since this barge lay on the Bering Sea beach it would pose a considerable threat of pollution. We reported this to the state authorities who had issued a permit to store "materials" in the barge, and the Federal Water Pollution Control Administration. It seems that the Corps of Engineers, when asked for approval by the oil company, did not communicate with either our Bureau or with the Bureau of Commercial Fisheries before issuing the permit. We played an active role in getting the oil transferred to an inshore tank, though not without feeling the pressure of the oil company's displeasure.

The Scripps Institute Research Vessel ALPHA HELIX conducting cold adaptation studies, called at Cold Bay several times early in the year. We participated in their activities when we could offer help. On one such occasion we assisted in the capture of sea otters.



Fig. 18 Refuge Manager Jones Ready to go on a Sea Otter Chase.
Photo by Dr. Carleton Ray

Refuge Manager Palmer Sekora completed flight training and received Bureau qualification.

Shile at Agattu we observed human bones protruding from a kitchen midden on an erosional surface. The sea had eroded the bank sufficiently to expose the bones. Since the winter storms would surely wash them away in a few months we elected to salvage them. We found four complete skeletons, three adult and one child of about eight years. These had been buried all in a heap with a whale scapula over them like a cover. The collection was sent to the museum of the University of Alaska.

Wilderness studies made improved progress this year with the appointment of Will Troyer to the project. Included in his work this year were the Izembek NWR and Simeonof NWR, both administered from this office. One of the more striking aspects of Simeonof are its white sand beaches, in direct contrast to the black sand beaches of the Izembek and Aleutian Islands NWR. The outer Shumagin Island group, in which Simeonof Island lies, is a granitic intrusion which accounts for the white sand.



Fig. 19 Simeonof Island. Note the White Sand Beaches. Photo by Palmer Sekora

In a year when many distinguished scientists visited us we were particularly delighted to have Dr. W. S. Laughlin of the University of Wisconsin visit, albeit briefly. Dr. Laughlin is recognized as the leading anthropologist with respect to the Aleut. Since we are custodian of most of the Aleut's ancestral area we had much in common.

Submitted by:

Robert D. Jones, Jr.
Refuge Manager

March 19, 1969

Approved:

OPTIONAL FORM NO. 10
5010-104

UNITED STATES GOVERNMENT

Memorandum

Supervisor
Associate
Asst. Mgmt-Id
Asst. Wash Or
Asst. [illegible]
Reg. Biol
Planner
Wilderness
Recreation
Mgt. Asst.
Secretary

x Reply o Review
— Handle / Comment
√ Discuss √√ File

TO : Recipients of the Aleutian Islands NWR Narrative 1968

DATE: 16 April 1969

FROM : Refuge Manager, Aleutian Islands NWR
Cold Bay, Alaska

SUBJECT: Correction to Aleutian Islands NWR Narrative 1968

We have found a serious error of omission on page 11 of our narrative and are enclosing a corrected copy. Please insert the corrected page and destroy the old one.

We regret this inconvenience.

Robert D. Jones, Jr.

OPTIONAL FORM NO. 10
5010-103

UNITED STATES GOVERNMENT

Memorandum

TO : Regional Director, BSF&W, Portland, Oregon DATE: March 25, 1969
ATTN: Regional Refuge Supervisor

FROM : Associate Supervisor, Alaska Wildlife Refuges, BSF&W, Anchorage, Alaska

SUBJECT: Aleutian Islands and Izembek Refuge Narrative Report

Regional Office and Central Office copies of subject report for 1968 are attached.

David L. Spencer

Encls: as cited

Reprinted from PACIFIC SCIENCE, Vol. XXII, No. 4, October, 1968

The Distribution and Biogeography of *Zostera marina* (Eelgrass) in Alaska[1]

C. PETER MCROY[2]

ALTHOUGH INNUMERABLE BOTANISTS have visited Alaska to record and study its flora, most accounts terminate at the high-tide line. Consequently, the marine vegetation, especially that of the most northern coasts of Alaska, has received little attention and the distributions of many species are sketchily known. *Zostera marina* Linnaeus, the common eelgrass, has probably received more interest than most, because of its importance as a waterfowl food. In spite of this, the distribution outlined by Hultén (1941:95, 1960:69, 1964:256) and other published sources (Anderson, 1959:48; Porsild, 1932:90–94; Polunin, 1940:40–41; Setchell, 1920:563–579, 1935:560–577; Murie and Scheffer, 1959:396) is very incomplete in the light of recent surveys of the coast. By compiling the results of personal efforts and communications over the past few years, I can now document in detail the distribution of this species in Alaska.

An additional result of searching and studying the distribution of *Zostera* in Alaska has been a review of the mechanisms of dispersion that have established and maintained this distribution. These aspects of the study of *Zostera* have in turn led to considerations of the biogeography of the species which can be reconstructed from distribution records and dispersion mechanisms.

Distribution Survey

The genus *Zostera* contains 11 species of shallow-water, soft-bottom marine plants (Setchell, 1935). The most widespread species of the genus, *Zostera marina*, occurs discontinuously throughout the boreal Northern Hemisphere from the seas of Okhotsk and Japan to the Baltic and Mediterranean (Setchell, 1935: 571). On the Pacific coast of North America *Z. marina* extends from Port Clarence, 65° N (Porsild, 1932:90) to Agiabampo Lagoon, 26° N, in the Gulf of California (Steinbeck and Ricketts, 1941:254).

In Alaska, *Zostera* forms a distinct subtidal zone in protected bays, inlets, and lagoons along the coast from Bering Strait south (Hultén, 1941:95). During 1967 I was able to survey many miles of the Alaska coast to locate and examine the *Zostera* beds. These surveys included Southeast Alaska, Prince William Sound, the Cold Bay region of the Alaska Peninsula, parts of the Seward Peninsula near Nome and Teller, the coast of the Chukchi Sea between Kivalina and Cape Thompson, and the vicinity of Point Barrow. The observations from these field trips have been combined with the published records and personal observations of several people to present a detailed listing of the locations of *Zostera* beds on the coast of Alaska (Fig. 1 and Table 1).

In Southeast Alaska, the Alexander Archipelago, *Zostera* is found in most of the bays and inlets of the outer coast, but it is absent from many of these on the inside waters (Fig. 1 and Table 1). This is apparently due to the turbid effluent of glaciers. No plants were found in any of the areas receiving large amounts of glacial runoff although other environmental conditions appeared quite suitable for their growth. For example, in Doty Cove and Limestone Inlet in Stephens Passage (near Juneau) the absence of *Zostera* is enigmatic in winter months when ambient waters are clear; but in summer the problem is solved by the presence of very turbid water from nearby Taku Inlet. In bays and inlets receiving quantities of the turbid glacial water the subtidal zone of soft bottoms usually occupied by *Zostera* is devoid of all macrophytes.

The coast from Cross Sound to Prince William Sound is rugged and exposed to the open sea; most of the existing bays harbor glaciers or glacial streams. *Zostera* has been reported only in Yakutat Bay (Setchell, 1920:567; Fig.

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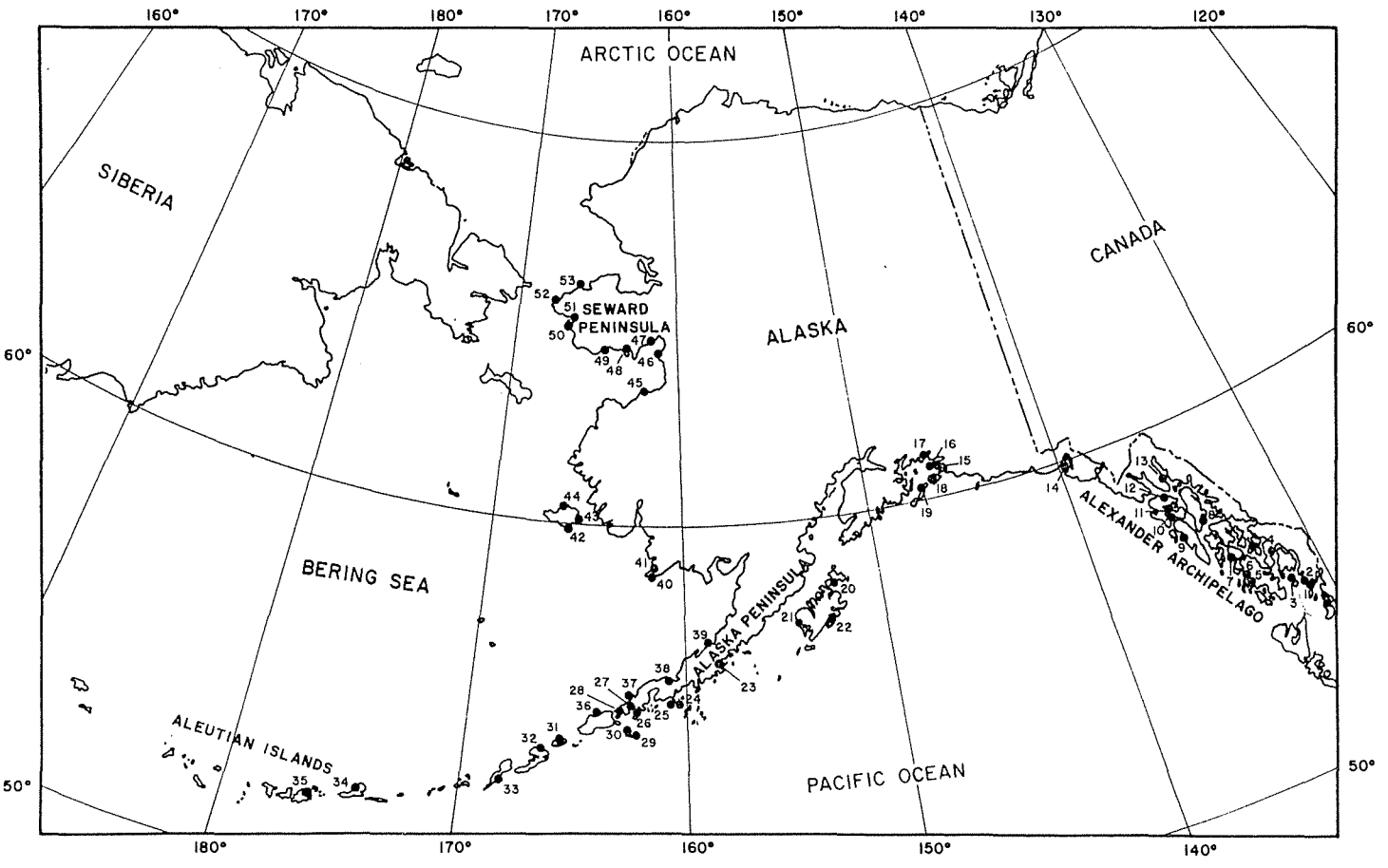


FIG. 1. Chart of Alaska showing the location of records of *Zostera marina* on the coast. Numbers refer to locations given in Table 1.

TABLE 1
RECORDS OF *Zostera marina* IN ALASKA

CHART NUMBER*	LOCATION	SOURCE
Alexander Archipelago		
1	Foggy Bay	Hultén, 1941
2	Cape Fox	Hultén, 1941
3	Gravina Lake	Hultén, 1941
4	Yes Bay	Hultén, 1941
5	Craig	Hultén, 1941
6	Klawak	McRoy, this study
7	Calder Bay	McRoy, this study
8	Pybus Bay	McRoy, this study
9	Sitka	Hultén, 1941
10	Hoonah Sound	McRoy, this study
11	Tenakee Inlet	McRoy, this study
12	Port Frederick	McRoy, this study
13	St. James Bay	Palmer, 1941
Cross Sound to Prince William Sound		
14	Yakutat Bay	Setchell, 1920
Prince William Sound		
15	Olsen Bay	Johansen, 1965
16	Redhead Lagoon	McRoy, this study
17	Sawmill Bay	McRoy, this study
18	Port Etches, Hinchinbrook Island	Johansen, 1965
19	Stockdale Harbor, Montague Island	Johansen, 1965
Kodiak Island, Alaska Peninsula and Aleutian Islands		
20	Afognak Island	Beals, 1941
21	Sturgeon River	Hultén, 1941
22	Port Hobron, Kodiak Island	Hultén, 1941
23	Chignik Bay	Hultén, 1941
24	Popof Island	Hultén, 1941
25	Unga Island	Hultén, 1941
26	King Cove	Hultén, 1941
27	Cold Bay	McRoy, this study
28	Morshovi Bay	McRoy, this study
29	Caton Island	Beals, 1941
30	Sanak Island	Beals, 1941
31	Akun and Akutan islands	Beals, 1941
32	Dutch Harbor	Beals, 1941
33	Vsevidof Island	Murie and Scheffer, 1959
34	Atka Island	Jones, 1965
35	Adak Island	Jones, 1965
36	Unimak Island	Hultén, 1941
Bering Sea		
37	Izembek Lagoon	McRoy, 1966
38	Herendeen Bay	McRoy, 1966
39	Port Heiden	McRoy, 1966
40	Nanvak Bay	King, 1963
41	Chagvan Bay	King, 1963
42	Ingrimiut, Nunivak Island	King, 1963
43	Ikongimuit, Nunivak Island	King, 1963
44	Mekoryuk, Nunivak Island	King, 1963
45	St. Michaels	Porsild, 1932
46	Malikfik Bay, Norton Sound	Porsild, 1932
47	Kwiniuk Inlet, Norton Sound	Porsild, 1932
48	Golovin Bay	Porsild, 1932
49	Safety Lagoon	Burns, 1967
50	Port Clarence	Kjellman, 1883
51	Grantly Harbor	McRoy, this study
Bering Straits		
52	Lopp Lagoon	Burns, 1967
53	Ikpek Lagoon	Burns, 1967

* Numbers refer to the geographical locations shown in Figure 1.

1 and Table 1). Isolated populations in other more inaccessible areas are of course possible. Prince William Sound contains many *Zostera* beds (Fig. 1 and Table 1), but their distribution was altered by the earthquake of March 1964. Johansen (1965:93–94) lists nine localities where he found dead *Zostera* attributable to the seismic uplift of the region. In June 1967 I revisited many of Johansen's stations. In several of these, the most striking being the vicinity of Cordova, no new *Zostera* was seen; in other places, such as Redhead Lagoon, reduced populations were evident.

The outer coast of the Kenai Peninsula is a glaciated region where no *Zostera* has been reported, nor has any been found in Cook Inlet, which might be expected from the turbidity and currents in the Inlet. There are, however, unconfirmed reports of *Zostera* in Kachemak Bay.

Several bays on Kodiak and Afognak islands, on the Alaska Peninsula, and in the Aleutian Islands contain *Zostera* beds (Hultén, 1941:95; Beals, 1941; Fig. 1 and Table 1). The western limit of the species in North America was Vsevidof Island (Murie and Scheffer, 1959: 369). This limit can now be extended to Atka and Adak islands (Jones, personal communication, 1965). The plants on Adak are evidently a result of transplantation experiments by the

U.S. Fish and Wildlife Service. No plants are known to occur in the western Aleutian Islands, probably due to the lack of protected bays. Plants are known from Kamchatka Peninsula and Bering Island on the Asian side of the Bering Sea (Hultén, 1926:75, 1960:69).

In the Bering Sea *Zostera* forms extensive meadows in the numerous coastal lagoons of the Alaska Peninsula (Fig. 1 and Table 1). The meadows in Izembek Lagoon on the Peninsula are the largest known single stand of the species (McRoy, 1966:103). Farther north, *Zostera* occurs in Nanvak and Chagvan bays and in many of the lagoons at the mouths of rivers on Nunivak Island (King, personal communication, 1963). No other *Zostera* beds have been found between King Salmon and St. Michael.

Porsild (1932:90–94) recorded the northern distribution of *Zostera* from St. Michael to Port Clarence (Fig. 1 and Table 1). Kjellman (1883:53) first observed *Zostera* in Port Clarence, the accepted northern limit in Alaska. Recently, *Zostera* has been seen beyond Bering Strait in the lagoons (Lopp and Ikpek) of the north coast of the Seward Peninsula (Burns, personal communication, 1967). I have also extended surveys to portions of the coast between Kotzebue and Barrow, but have not uncovered any other *Zostera* producing areas.

Mechanisms of Dispersion

The distribution of *Zostera* in Alaska and elsewhere in the Northern Hemisphere is the result of dispersion by several mechanisms. Oceanic currents appear to be the most effective means of long range dispersion, although there is some disagreement on this. Löve (1963:195) observes that saltwater plants are adapted to dispersal in sea water and cites as an example the seeds of *Zostera* with their corky appendages and bouyant vegetative parts. Sculthorpe (1967: 358), on the other hand, considers Löve's view of dispersal an "unfortunate generalization," since the seeds of *Zostera* and other marine angiosperms either float for only a short time or sink immediately. The seeds of *Zostera* have a specific gravity of 1.17 (Arasaki, 1950:70–76), a value somewhat greater than the 1.025 average of the ocean (Von Arx, 1962:118) and so would be expected to sink. In fact, however, the seeds are released attached to a reproductive stem which has several leaves and is capable of floating for long distances. Mats of *Zostera* and other marine angiosperms have been seen at sea several hundred miles from the coast (Menzies, Zaneveld, and Pratt, 1967: 112). There can be no doubt that dispersion on a large scale is accomplished through the seed-producing and perhaps vegetative plants that annually detach and drift with oceanic surface circulation.

The several species of waterfowl that feed on *Zostera* are another vehicle for dispersion. Löve and Sculthorpe concur. Arasaki (1950: 70–76) demonstrated that ducks do not destroy the viability of all seeds they ingest. The coast of Alaska is a flyway for numerous species of waterfowl that annually transport seeds over at least short distances and probably farther. This is a mechanism for dispersion in a direction opposite to that of the coastal oceanic currents.

In a local area *Zostera* extends its cover principally by vegetative growth from rhizomes, a process quantitatively more important than the growth of new seed plants. Again, Arasaki (1950:70–76) has shown that a single plant will cover 30 cm^2 the first year, 1 m^2 the second, and 2 m^2 the third. At this rate, it would not take long for a population to develop in a new area once a plant has been introduced.

Biogeographical Considerations

The global distribution of this species is discontinuous circumboreal. The other species of the seagrasses, with few exceptions, are tropical or subtropical and are considered to have originated in the Indian Ocean (Setchell, 1935: 564–572). The genus *Zostera*, however, has no tropical representatives and apparently arose in the western Pacific Ocean, dispersing into the Northern and Southern hemispheres at a time when the tropics were less tropical. This history is supported by the present distribution of the 11 species of *Zostera* (Setchell, 1935:572) and the locations of fossils of *Zostera* ancestors in Japan (Koriba and Miki, 1930:165–204; Miki, 1932:774–778).

If the origin of *Zostera marina* was the western Pacific, then migration could have taken either of two routes. In the first case, dispersion could have moved in two directions from the

origin, populating both sides of the Pacific Ocean in one direction and through the Indian Ocean and the Mediterranean Sea to both sides of the Atlantic Ocean in the other. Setchell (1935:572) suggested that a route of this sort could have occurred at a time, probably in the early Tertiary, when the Tethys Sea covered much of the Northern Hemisphere. The other possibility for dispersion is a one-way movement. This is really an argument for a one-way dispersion route through the Pacific Ocean rather than through the Indian Ocean. This path would result logically in the present distribution of the species. The theory demands that the Atlantic and its adjacent seas were populated by migration through the Arctic during a prehistoric milder climate, which should be entirely possible, for, as the distribution in Alaska illustrates, *Zostera marina* is a cold-tolerant species. If continuity through the Arctic once existed, relict populations would be expected along the Arctic coast. These do exist in the White Sea, the Barents Sea, the Kara Sea, and Hudson Bay (Zenkevitch, 1963:195–198; Blinova, 1962:150; Setchell, 1920:567; Porsild, 1932:91). Ekman (1953:160–164) describes similar patterns for many species of marine invertebrates and vertebrates that have discontinuous distributions in the Pacific and Atlantic oceans. Additionally, Durham and MacNeil (1967:343) report that a large number of species, more than 125, of marine invertebrates have dispersed from one ocean to the other mostly in one direction—into the Arctic-Atlantic; they consider these migrations to have occurred during the late Cenozoic.

The evidence available indicates that *Z. marina* originated in the western Pacific and dispersed to the north along the coast of Asia and then around to North America. Its tolerance to low temperatures permitted it not only to cross the subarctic Pacific to North America, but also to populate the Arctic and move eventually to both shores of the Atlantic. Perhaps in times of cooler climates migration continued into the north coast of the Mediterranean Sea and its adjacent seas. No other species of *Zostera* has this widespread distribution, nor is there another one tolerant to low temperatures. The single closely related species that has a similar, but more restrictive, temperature tolerance is *Phyllospadix scouleri* Hook which is endemic to the temperate Pacific Ocean. This species provides an example of the limited distribution of a less cold-tolerant species originating in the same area; it never reached the Atlantic. The opposite situation is illustrated by the distribution of *Zostera nana* Roth, a species less tolerant to cold water but more so to warm water; it is limited to the western Pacific, but has also been able to move through the Indian Ocean to populate parts of Africa, the Mediterranean (both north and south) and parts of the southern Atlantic coast of Europe.

SUMMARY AND CONCLUSIONS

Zostera marina, eelgrass, is a common inhabitant of the Alaska coast, occurring from the lagoons on the north coast of the Seward Peninsula to the southern limit of Alaska and beyond. New records of *Zostera* in Alaska are from Adak and Atka in the Aleutian Islands, Chagvan and Nanvak bays and Nunivak Island, and Lopp and Ikpek lagoons on the Seward Peninsula. In Prince William Sound the distribution of *Zostera* was markedly altered by uplift associated with the earthquake of March 1964.

Zostera grows in the soft sediments of shallow, protected marine bays, inlets, and lagoons. It is excluded from large river deltas, glacial fjords, and arctic environments. The distribution in Alaska is disjunct, a result of environmental restrictions rather than a lack of dispersion mechanisms. Global dispersion is a result of oceanic circulation and waterfowl migrations. Vegetative growth is the most important means of extending coverage of a restricted area. In view of the present distribution of the species and the geological structure of the Alaska coast, no extensions of the range of *Zostera* are expected. Populations may exist, of course, in remote places along the coast.

Alterations in the present distribution are possible only with major geological or climatic changes. Seismic uplift or depression of the south coast of Alaska could eliminate a large portion of the present populations. On the other hand, amelioration of conditions in arctic waters by a change in ice conditions could permit further extension of the present range.

The circumboreal distribution of *Z. marina*

is considered to be a result of dispersion from a western Pacific origin around the Pacific and through the Arctic into the Atlantic and its adjacent seas. That this was the path of migration is supported by the present distribution of the species, the location of its fossil ancestors, and similar dispersal patterns for marine invertebrates.

The migration and present distribution of *Z. marina* have resulted from the eurythermality of the plant. This feature probably also permitted survival during oscillating Pleistocene climates.

The *Zostera* communities on the Alaska coast are important contributors to all levels of production in the food web and provide refuges to innumerable species of organisms. Research is in progress on the ecology of these interesting communities.

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Revision of the Genus *Pandanus* Stickman, Part 29
New Papuan Species in the Section *Microstigma* Collected by C. E. Carr

HAROLD ST. JOHN[1]

THE ISLAND of New Guinea has a large concentration of species of *Pandanus,* and it is evident that they have been only partly collected and studied. They occur in nearly all plant formations from sea level to 3300 meters altitude. The three species here described were collected by C. E. Carr in 1935. He attempted to cross the Owen Stanley Range, from south to north, but lost his life in the attempt.

Section *Microstigma*

Pandanus Carrii sp. nov. (sect. *Microstigma*) Fig. 272

DIAGNOSIS HOLOTYPI: Arboriformis 5 m alta, radicibus trunco ramis syncarpioque incognitis, foliis 1.14 (+0.02–0.05?) m longis proxima basem 3.6 cm latis in medio 2.6 cm latis coriaceis supra viridibus infra pallidioribus U-sulcatis 2-plicatis in sectione mediali cum 49 nervis parallelis secundariis in quoque dimidio nervis tertiis nullis lamina anguste gladiata ex basi sensim in apice crasso subulato (apex deest) basi inermi pallida, ex 11–13 cm marginibus cum aculeis 2–2.5 mm longis 6–12 mm separatis arcuatis fragilibus subulatis valde adscendentibus pallidis vel cum apicibus rubris, in sectione mediali marginibus cum aculeis 1.7–2 mm longis 5–12 mm separatis subarcuatis subulatis gracilibus subadpressis adscendentibus apicibus rubris, midnervo infra inermi, in apice subulato marginibus cum crenati-serrulis 0.2–0.3 mm longis 2–5 mm separatis rubris, syncarpio viridi, drupis 7.7–7.8 cm longis 1.4–1.6 cm latis 1.1–1.4 cm crassis prismaticis 6-angulosis, pileo 13–17 mm alto deciduo laevi exlucido dimidio infero late obtuso 6-anguloso dimidio supero rostrato crasso, stigmate 6–7 mm longo late elliptico obliquo brunneo papilloso sulcato, endocarpio submediali 4.3 cm longo subcylindrico cuneato osseoso obscure brunneo lateribus lateralibus 0.7–1.5 mm crassis intra laevibus lucidis, mesocarpio extra endocarpii cum fibris et eis ad stigmatem convergentibus, exocarpio et mesocarpio molliter carnoso et in fructu delapso et in sicco nigro, mesocarpio apicali extra cum fibris longitudinalibus sed intra cum membranis, mesocarpio basali carnoso et in sicco valde contracto.

DIAGNOSIS OF HOLOTYPE: Tree-like, 5 m tall; roots, trunk, branches, and syncarp unknown; leaves 1.14 (+0.02–0.05?) m long, 3.6 cm wide near the base, 2.6 cm wide at the middle, coriaceous, above green, below paler green, U-sulcate, 2-pleated, at midsection with 49 parallel secondary veins in each half, no tertiary cross veins, blade narrowly sword-shaped, tapering gradually from near the base into the stout subulate apex (the actual tip missing), the base pale, unarmed, beginning at 11–13 cm up the margins with prickles 2–2.5 mm long, 6–12 mm apart arcuate weak subulate, strongly ascending, wholly pale or with red tips; the nearby midrib below not visible; at midsection the margins with prickles 1.7–2 mm long, 5–12 mm apart, subarcuate slender subulate, almost appressed ascending, red-tipped; the midrib below unarmed; near the apex the margins with crenate-serrulations 0.2–0.3 mm long, 2–5 mm apart, red; those of the midrib below not observed; syncarp "green"; drupes 7.7–7.8 cm long, 1.4–1.6 cm wide, 1.1–1.4 cm thick, prismatic, 6-angled; pileus 13–17 mm high, deciduous, smooth, dull, the lower half forming the broadly obtuse base, this 6-angled, bearing a thick beak; stigma 6–7 mm long, broadly elliptic, oblique, brown, papillose, sulcate; endocarp submedian, 4.3 cm long, subcylindric, tapering downward, the apex arched, bony, dark brown, the lateral walls 0.7–1.5 mm thick, within smooth, shiny; mesocarp with thick fibers up the sides of the endocarp and bending in toward the stigma; exocarp and lateral mesocarp soft fleshy, and at maturity sloughing off and drying black; apical mesocarp with fibers up the sides and within partitioned by pale membranes and filaments; basal mesocarp fleshy and at maturity much shrunken.

HOLOTYPUS: Papua, Koitaki (on track to Owen Stanley Mountains pass), open savannah land, 1,500 ft alt, 13. 5. 1935, *C. E. Carr 12,274* (BM). Isotype (K)!

DISCUSSION: *P. Carrii* is a member of the section *Microstigma,* as is its closest relative, *P. Jiulianettii* Martelli, a species with drupes 9.5–

[1] B. P. Bishop Museum, Honolulu, Hawaii 96819, U. S. A. Manuscript received March 7, 1964.